

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of)	IB Docket No. 11-109
)	IB Docket No. 12-340
Ligado Applications to Modify the Ancillary)	
Terrestrial Component (ATC) of Its L-Band)	SAT-MOD-20151231-00090, SAT-MOD-
Mobile Satellite Service (MSS) Networks)	20151231-00091, SES-MOD-20151231-
)	00981

**REPLY COMMENTS OF AIRCRAFT OWNERS AND PILOTS ASSOCIATION,
AIRLINES FOR AMERICA, AVIATION SPECTRUM RESOURCES, INC., BRISTOW
GROUP, INC., HELICOPTER ASSOCIATION INTERNATIONAL, INTERNATIONAL
AIR TRANSPORT ASSOCIATION, NATIONAL AIR TRANSPORTATION
ASSOCIATION, NATIONAL BUSINESS AVIATION ASSOCIATION, SOUTHWEST
AIRLINES, UNITED PARCEL SERVICE ("JOINT AVIATION REPLY
COMMENTERS")**

AIRCRAFT OWNERS AND PILOTS ASSOCIATION	INTERNATIONAL AIR TRANSPORT ASSOCIATION
--	--

Melissa K. Rudinger
Vice President Government Affairs
421 Aviation Way
Frederick, Maryland 21701

Douglas E. Lavin
Vice President, Member and External
Relations, North America International
1201 F Street NW Suite 650
Washington DC 20004

AIRLINES FOR AMERICA

NATIONAL AIR TRANSPORTATION
ASSOCIATION

Captain Billy Nolen
Senior Vice President, Safety, Security, and Operations
1301 Pennsylvania Avenue, NW Suite 1100
Washington DC 20004-1707

John McGraw
Director, Regulatory Affairs
818 Connecticut Avenue, NW, Suite 900
Washington, D.C. 20006

AVIATION SPECTRUM RESOURCES, INC.

Kris Hutchison
President
180 Admiral Cochrane Drive Suite 300
Annapolis, MD, 21401

NATIONAL BUSINESS AVIATION
ASSOCIATION

Bill Stine
Technical Advisor
1145 Water Pointe Lane
Reston, Virginia 20194-1035

BRISTOW GROUP, INC.

Robert Phillips
VP, Global Business Operations Services
2103 City West Blvd #4
Houston, TX 77042

SOUTHWEST AIRLINES

Neal Young
Manager, Aircraft Communication
2432 Wyman Street
Dallas, TX 75235

HELICOPTER ASSOCIATION INTERNATIONAL

Matthew S. Zuccaro
President & CEO
1920 Ballenger Avenue
Alexandria, VA 22314-2898

UNITED PARCEL SERVICE

Dontai Smalls
Vice President, Public Affairs
316 Pennsylvania Ave. SE
Suite 300
Washington, DC 20003-1173

June 21, 2016

SUMMARY

The record developed in response to the Public Notice seeking comment on the license modification applications of Ligado (the “Applications”) reveals unequivocally that unresolved concerns continue to exist regarding potential harmful interference from the proposed Ligado terrestrial operations. Ligado’s June 6, 2016, Reply Comments (the “Ligado Reply”) acknowledges many of these unresolved interference issues yet does not offer any solutions. Instead, Ligado places undue emphasis on ongoing discussions with interested parties, including the GPS manufacturers with whom Ligado entered into settlement agreements last year. While Ligado has engaged with many parties as it seeks to assuage threats to a variety of existing operations – and this is welcome – the Joint Aviation Reply Commenters submit that Ligado’s intentions and discussions in themselves are not grounds for a grant of the Applications. Rather, until the identified interference issues have been adequately studied and solutions have been rigorously developed and vetted, the Commission should not act on the Applications.

Unresolved interference concerns are perhaps most severe in the case of certified aviation GPS receivers. Harmful interference to these receivers would have serious implications for aviation safety and the reliability of airline operations on which the nation’s economy and the flying public depend. Ligado’s clarifications in its Reply concerning its proposed “FAA condition” as a solution to these concerns helps to better define its proposed concept, but numerous details still need to be studied and substantial practical questions remain regarding implementation, administration, and enforcement. At present, the FAA has not published its views on whether the “FCC condition” is viable and many aspects of the proposal remains too rudimentary and undefined to be a basis for a grant of the Application at this time.

In addition to the issues concerning compatibility of Ligado's proposed operations with non-certified aviation receivers, there remain substantial concerns regarding potential harmful interference to non-certified, or standard, GPS devices. Virtually every commenter addressing the issue, except Ligado, supports testing based on the domestically and internationally well-established metric of a 1 dB degradation in the signal-to-noise ratio such as the Adjacent Band Compatibility Study being undertaken by the Department of Transportation. Most commenters find the Ligado proposal to conduct testing based on "key performance indicators" – specifically the accuracy of the device reported location – to be inadequate. Tellingly, Garmin and Trimble, both of which entered into settlement agreements with Ligado, each characterize the Ligado-proposed testing approach as unreliable and impractical. NovAtel identified a number of methodological flaws in its comments with Ligado's study approach, and the Joint Aviation Reply Commenters discuss a number of other shortcomings in its reply.

Finally, several commenters, like the Joint Aviation Parties, pointed out the grave potential for harmful interference to important Inmarsat and Iridium satellite communications ("SATCOM"). For example, while Iridium states it is in discussions with Ligado regarding these concerns, it also leaves no doubt that the proposed modifications in the Applications would lead to serious impacts. Significantly, Ligado does not address the issue of harmful interference to SATCOM at all in its Reply.

The foregoing complex issues must each be addressed fully before the Commission can act on the Applications. The Commission should not put the cart before the horse and grant Ligado's proposed modifications based on Ligado's mere promise to continue ongoing discussions with the FAA, Iridium, Garmin, Trimble, and others. To do so would be inconsistent with the public interest in preserving aviation safety and the reliability of the nation's airline

operations. Furthermore, it risks repeating the actions of 2011 at great cost to the Commission and all parties involved, when the Commission granted a provisional waiver to LightSquared conditioned on a subsequent showing of compatibility with GPS receivers, a showing Ligado ultimately could not make. The Joint Aviation Reply Commenters are committed to work with the interested parties to identify the scope of additional work that must be done and explore possible solutions.

TABLE OF CONTENTS

<u>SUMMARY</u>	i
<u>I. INTRODUCTION: THE COMMENTS REFLECT SUBSTANTIAL REMAINING CONCERNS ABOUT POTENTIAL INTERFERENCE THAT MUST BE RESOLVED PRIOR TO A GRANT OF THE REQUESTED MODIFICATIONS</u>	3
<u>II. THE LIGADO REPLY STILL LEAVES MANY OPEN ISSUES</u>	6
1. Serious Unresolved Issues Remain Regarding Certified Aviation Receivers.....	7
2. Ligado Has Not Demonstrated That the Proposed Operating Conditions Will Protect Non-Certified Receivers Used by the Aviation Industry and Many Others.....	13
3. The Ligado Reply Does Not Acknowledge the Concerns Regarding Satellite Communications	16
<u>III. CONCLUSION</u>	19

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	IB Docket No. 11-109
Ligado Applications to Modify the Ancillary)	IB Docket No. 12-340
Terrestrial Component (ATC) of Its L-Band)	
Mobile Satellite Service (MSS) Networks)	SAT-MOD-20151231-00090, SAT-MOD-
)	20151231-00091, SES-MOD-20151231-
		00981

**REPLY COMMENTS OF AIRCRAFT OWNERS AND PILOTS ASSOCIATION,
AIRLINES FOR AMERICA, AVIATION SPECTRUM RESOURCES, INC., BRISTOW
GROUP, INC., HELICOPTER ASSOCIATION INTERNATIONAL, INTERNATIONAL
AIR TRANSPORT ASSOCIATION, NATIONAL AIR TRANSPORTATION
ASSOCIATION, NATIONAL BUSINESS AVIATION ASSOCIATION, SOUTHWEST
AIRLINES, UNITED PARCEL SERVICE ("JOINT AVIATION REPLY
COMMENTERS ")**

Aircraft Owners and Pilots Association ("AOPA"), Airlines for America, Aviation
Spectrum Resources, Inc. ("ASRI"), Bristow Group, Inc. ("Bristow"), Helicopter Association
International ("HAI"), International Air Transport Association ("IATA"), National Air
Transportation Association ("NATA"), National Business Aviation Association ("NBAA"),¹
Southwest Airlines, and United Parcel Service ("UPS")² ("Joint Aviation Reply Commenters ")

¹ Founded in 1947 and based in Washington, DC, the National Business Aviation Association is the leading organization for companies that rely on general aviation aircraft to help make their businesses more efficient, productive and successful. NBAA represents more than 10,000 companies and provides more than 100 products and services to the business aviation community, including the NBAA Business Aviation Convention & Exhibition, the world's largest civil aviation trade show.

² All of the Joint Aviation Reply Commenters with the exception of NBAA participated in the comments of the Joint Aviation parties filed in the above-referenced proceedings on May 23, 2016, and the descriptions of those parties can be found in those comments.

hereby submit its responsive comments in the above-referenced proceedings to the Reply Comments of Ligado Networks LLC (“Ligado”)³ as provided for in the Commission’s April 22, 2016, Public Notice seeking comment on the December 31, 2015, license modification applications of Ligado.⁴ The record in these proceedings developed in response to the Public Notice leaves no doubt that it would be premature for the Commission to grant the Applications. As made clear by the comments of interested parties and the Ligado Reply, numerous issues remain unresolved. The Joint Aviation Reply Commenters welcome the opportunity to engage with Ligado to help identify the scope of additional work to be done and the exploration of possible solutions. But, until those various issues are resolved satisfactorily, the Commission should refrain from acting on the Applications.⁵ If it should be the case, ultimately, that those issues cannot be resolved in a manner that adequately protects aviation safety and otherwise is consistent with the public interest, the Commission should, as appropriate, dismiss the Applications.

³ Reply Comments of Ligado Networks LLC, IB Docket No. 11-109 (filed June 6, 2016) (“Ligado Reply”).

⁴ *Comment Sought on Ligado’s Modification Applications*, Public Notice, IB Docket Nos. 11-109 and 12-340 (rel. Apr. 22, 2016) (“Public Notice”); *see also* Applications of LightSquared Subsidiary LLC, Narrative, IBFS File Nos. SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, and SES-MOD-20151231-00981 (filed Dec. 31, 2015) (“Applications”). Contemporaneously with filing the Applications, Ligado withdrew its 2012 request to modify its MSS licenses.

⁵ Ligado notes in its Reply that no party filed a petition to deny. Ligado Reply at 2. While this is true, this fact does not obviate the need for the Commission that it should only grant the applications if the serious interference issues that have been raised and are ongoing are resolved consistent with the public interest.

I. INTRODUCTION: THE COMMENTS REFLECT SUBSTANTIAL REMAINING CONCERNS ABOUT POTENTIAL INTERFERENCE THAT MUST BE RESOLVED PRIOR TO A GRANT OF THE REQUESTED MODIFICATIONS.

In their initial comments, ASRI (and the other Joint Aviation Parties) recommended that a grant of the Applications on the current record would be premature given the outstanding issues, especially those concerning aviation safety and reliability of aviation operations, which must first be addressed to a satisfactory conclusion. The Joint Aviation Parties did not oppose the Applications *provided that* all the concerns are satisfactorily resolved. By implication, however, if those issues are not suitably resolved, the Applications should be denied.

As detailed herein, many other commenters identified serious unresolved concerns with the Applications. Indeed, the Ligado Reply itself confirmed many key issues still need to be addressed. As a threshold matter, it is significant that two of the three parties with whom Ligado has reached settlement agreements, Trimble and Garmin, are among the parties describing serious unresolved interference and testing issues. Trimble, for example, in a written *ex parte* presentation filed June 8, 2016, in Docket 11-109, explained that substantial issues concerning the potential for interference to standard GPS receivers remain.⁶ Although Trimble claimed, being bound by its settlement agreement, that grant of the Applications can be made “without addressing more generally the criteria by which GPS receivers should be protected from other terrestrial operations,” it made clear that issue remained to be resolved, noting that “Trimble

⁶ See Letter from Russell H. Fox, Counsel, Trimble Navigation Limited to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 11-109 et al. (filed June 8, 2016).

expects discussions to continue regarding Ligado's proposed use of the 1526-1536 MHz band."⁷

In short, from Trimble's perspective, not all concerns regarding potential interference to GPS receivers have yet been settled. Indeed, Trimble, in its May 23, 2016, comments, criticized Ligado's testing regime and criteria as "unreliable and impractical" and advocated for continued use of the well-established existing signal-to-noise ratio criterion: "establishing harmful interference as a 1 dB decrease in C/N_0 has become the universally employed metric because it yields meaningful results across a variety of test configurations and across all four performance attributes."⁸

Garmin was equally clear on this point, noting in its comments that use of the 1 dB metric for potential interference to GPS receivers is "essential."⁹ Garmin challenged the adequacy of Ligado's efforts to introduce a different metric to qualify GPS interference.¹⁰ Garmin also underscored the lack of resolution of issues concerning certified aviation receivers.¹¹ Garmin explained that despite its settlement agreement with Ligado, "Garmin's comments should not be read as an endorsement of Ligado's proposed network or an indication of resolution of all issues

⁷ *Id.* at 2.

⁸ Comments of Trimble Navigation Limited at 14.

⁹ Comments of Garmin International Inc. at 8-12.

¹⁰ *Id.* at 18.

¹¹ *Id.* at 2.

regarding certified aviation devices that may be raised by establishment of Ligado's high power terrestrial network under the parameters proposed in its Modification Application."¹²

The comments of Garmin and Trimble underscore an important point reflected in many other comments and even the Ligado Reply: a variety of significant issues remain the subject of diverse sets of discussions among Ligado and other parties.¹³ While this is a constructive development, and may yield positive results, the mere fact that Ligado is in discussions to address certain issues, no matter how good faith those discussions have been and may continue to be, is not sufficient proof that the issues that are the subject of the discussion have, or will be, satisfactorily resolved. Ligado, in its Reply, seems to imply that the existence of such discussions signifies that resolution of the underlying issues is assured. For example, Ligado claims that its "discussions with the FAA are addressing not only the calculation of the necessary safe power limits but also the process by which the FAA can ensure Ligado's compliance without imposing undue burdens on the agency's staff" among other substantial matters.¹⁴ These are complex and difficult matters, and there is no guarantee that the discussions will be successful. To grant the Applications based on Ligado's intentions to resolve these issues, would

¹² *Id.*

¹³ Ligado acknowledges in its Reply that it is in discussions with TopCon and "working cooperatively to address Topcon's concerns," and "remains in active discussions to address concerns raised by other stakeholders, such as NovAtel" (p. 3, n.2). Ligado also notes that it is in discussions with the FAA to address numerous issues related to compatibility with aviation operations. *Id.* at 7-8. Iridium notes that it is in discussions with Ligado to attempt to resolve potential impacts to satellite communications from the proposed terrestrial operations. Comments of Iridium at 2-3.

¹⁴ Ligado Reply at 7-8. *See also id.* at 6.

be premature. The Commission should not proceed in that fashion and grant the Applications purely based upon the promise of resolution. This approach has been attempted before, in 2011, when the Commission granted a provisional waiver to LightSquared conditioned on a subsequent showing of compatibility with GPS receivers, a showing LightSquared ultimately could not make. The Commission should not risk repeating this scenario by granting the Applications before the issues that have been raised by the parties have been resolved.

Certainly, the Commission should encourage such discussions, and the Joint Aviation Reply Commenters welcome them. But only once the potential interference issues are fully identified and *demonstrated as resolved* should the Commission proceed to grant the Applications. Action on the Applications prior to that time would be premature and contrary to the public interest.

II. THE LIGADO REPLY STILL LEAVES MANY OPEN ISSUES

In its Reply, Ligado seeks to address some of the open issues, particularly with regard to certified aviation receivers and standard GPS devices, but it fails to do so in a manner that would warrant FCC action on the Applications at this time. Moreover, the Ligado Reply completely overlooks the concerns raised with respect to potential interference to satellite communications (“SATCOM”) by several parties. All of these issues must be fully resolved before the Commission can act on the Applications. To grant the Applications prior to full resolution would postpone proper consideration of serious concerns about prospective harmful interference, potentially gravely compromise aviation safety, and threaten the reliability of aviation operations upon which the economy and the nation's citizens depend. Thus, a premature grant would not be in the public interest.

1. Serious Unresolved Issues Remain Regarding Certified Aviation Receivers.

Several commenters in addition to the Joint Aviation Parties raised issues concerning the potential for interference under the proposed operating conditions to certified aviation receivers, including Boeing,¹⁵ the Aerospace Industry Association,¹⁶ and the Air Line Pilot Association, International.¹⁷ Boeing in particular criticized the potential flaws with the “FAA condition” proposed by Ligado by which Ligado intends to protect certified aviation GPS receivers from interference. Boeing correctly observes that “a condition based on compatibility with current and future [Minimum Operational Performance Standards (“MOPS”)] that are incorporated into an active Technical Standard Order [(“TSO”)] from the FAA” “raise[s] oversight questions because the FAA and RTCA are the expert agencies with regard to aviation matters, but, as a non-aviation entity, Ligado will not be subject to their jurisdiction.”¹⁸ The Joint Aviation Reply Commenters concur with Boeing that if the FAA condition ultimately proves acceptable to the FAA and RTCA – neither body has yet provided its judgment on the matter – it will require the Commission to ensure effective regulatory oversight that the Commission is willing and able to implement. The enforcement framework must account for the proper and ongoing interpretation

¹⁵ Comments of Boeing at 3-4.

¹⁶ Comments of Aerospace Industries Association at 2.

¹⁷ Comments of Airline Pilots Association International at 1.

¹⁸ Comments of Boeing at 3.

of Ligado's terrestrial operational parameters by the FAA to ensure compatibility with the relevant MOPS.¹⁹

In its Reply, Ligado offers considerable clarifications on its "FAA condition" proposal, albeit it does not address certain core implementation issues.²⁰ Specifically, Ligado notes that, under its proposal, Ligado would itself calculate specific power limits, in consultation with RTCA and subject to the FAA's concurrence, and be under a continuing obligation to adjust its power levels to ensure compatibility with certified GPS receivers operating under any active MOPs, whether already in existence today or adopted in the future.²¹ This clarification is welcome, as it is important to recognize that any limits imposed on Ligado's emissions to protect certified aviation GPS receivers by an FAA-led process with RTCA involvement must be subject to review and change should there be any future aviation safety concerns. It is equally critical that compatibility always be based on the most conservative avionics standard in use by commercial aviation, which Ligado's clarification concedes. However, even with Ligado's conceptual clarification, a number of issues and concerns remain before the FAA condition can actually be articulated in an operational manner in any prospective grant of the Applications.

First and foremost, it is not clear that the FAA supports this approach or has concluded that there are limits for operations in the 1526-1536 MHz band, or any other Ligado licensed frequency band, that will adequately protect all aviation safety operations. The Joint Aviation

¹⁹ *Id.* at 4.

²⁰ Ligado Reply at 6.

²¹ *Id.*

Reply Commenters are awaiting additional information from the FAA as it continues its examination of Ligado's proposal, and will seek to further the dialogue in these proceedings as these details become available.

Second, it is not clear how "compatibility with certified aviation GPS devices" will be measured and how adherence to what Ligado calls "operational deference" will be ensured. While the Joint Aviation Reply Commenters recognize Ligado's offer to conduct the assessment, it is obvious that the FAA must be the primary lead organization to conduct the testing of such conditions in an objective manner, which Ligado would be involved with through the RTCA process in supporting the FAA's technical analysis. Additionally, the FAA would also be the most appropriate body to coordinate additional resources or organizations that may not be available to work with Ligado should the need arise.

Third, Ligado must explain how it will cease operation of any Ligado equipment that is deemed to pose an immediate hazard to aviation without having to await completion of an FCC investigation into the interference. This aspect of any sharing arrangement is critical because aviation safety and reliability of operations could be disastrously compromised in the interim.

Fourth, the FAA license condition must be applicable to all emissions from Ligado's terrestrial network, from both base stations and handsets. While Ligado has provided some analysis to support its claims that handsets do not affect aviation GPS receivers, these have yet to be fully assessed by the relevant experts at FAA or RTCA, and so Ligado's study attached to its Reply cannot be considered conclusive at this time. Moreover, the Ligado emission profile limits out-of-band emissions ("OOBE") to set values, yet Ligado fails to address other unwanted emissions from non-linear elements of its equipment that may affect certified GPS receivers by

falling within or near the GPS receivers' bandwidth. These other emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, especially when narrowband signals are used by multiple handsets. Furthermore, Ligado claims that their analysis showed “no impact to existing or emerging GNSS systems”. However, the assessment does not include analysis on impact to other Global Navigation Satellite Systems (“GNSS”) such as Galileo and Beidou, which were recognized as emerging GNSS by ICAO Air Navigation Conference.²²

Fifth, as discussed earlier, and as raised by Boeing, the role and commitment of the Commission, which has regulatory and enforcement jurisdiction over Ligado, needs to be adequately defined and established.

Sixth, Ligado correctly recognizes that it must account for the worst case scenario and act conservatively and vows that it must “ensure [that its] power is limited to the level necessary to ensure compatibility even with the [] most difficult use cases.”²³ Ligado describes helicopters as the “hardest case” for it to demonstrate compatibility.²⁴ As a consequence, it explains that “helicopters would necessitate [a] substantially lower power limit on a nationwide basis until the helicopter situation was resolved.”²⁵ While, in principle, this recognition is welcome, as a

²² Twelfth Air Navigation Conference Report, Recommendation 6/6: Use of multiple Constellations International Civil Aviation Organization, Doc. 10007, AN-Conf/12, Nov. 19-30, 2012, available at: http://cfapp.icao.int/tools/ATMiKIT/story_content/external_files/10007_en.pdf

²³ Ligado Reply at 7.

²⁴ *Id.* at 6.

²⁵ *Id.* at 7.

practical matter any proposed solution to address the “situation” of potential interference to helicopters would need to be developed in tandem with the helicopter community and manufacturers.

Seventh, once sufficient analysis is completed, it may be that the helicopter “situation” is not the hardest case Ligado must resolve. The Joint Aviation Reply Commenters submit that UAVs may actually prove the more difficult interference scenario for Ligado to resolve. The case of UAVs has not, to the Joint Aviation Reply Commenters' knowledge, been considered in Ligado's Applications or supporting material. The Joint Aviation Reply Commenters suggest that interference to medium sized unmanned aerial systems being planned for urban environments are worthy of consideration given the expected significant increase in deployment of the systems, and possible applications for air cargo carriers. The potential interference issues to UAVs and the solutions must be adequately considered before the Commission acts on the Applications.

Finally, Ligado tries to dismiss the 2012 FAA study as no longer relevant, specifically on the grounds that it proposes to operate at lower peak powers.²⁶ While all parties agree that the Ligado base station power values need to be modified to be compatible with aviation GPS, the Joint Aviation Reply Commenters submit that the methodology of the 2012 FAA study is still a valid foundation for any future compatibility study requirements at this time. Changing the base

²⁶ *Id.*

power levels is unlikely to significantly undermine the methodology of the FAA report.²⁷ Until additional FAA study further clarifies the interference environment and the necessary GPS protections required, a maximum Ligado base station output power of 7.9 dBW is still the most valid limit to protect all existing aviation operations for GPS tracking and acquisition functions. The 15 dBW range value suggested by Ligado in its filing does not seem to correlate with the existing FAA study from 2012, and the Joint Aviation Reply Commenters would seek clarification on how Ligado has arrived at this value for such a usage scenario.²⁸

Accordingly, as the above discussion makes clear, numerous issues require further investigation and technical verification. Ligado's intentions are not a sufficient basis for a grant, and it would be premature to grant the Applications without the significant work discussed above being completed to a satisfactory conclusion for aviation safety. Furthermore, it should be noted that should the results of the above work significantly change Ligado's operational deployment plan, then this would also need to be fully re-assessed to ensure appropriate protections for aviation safety.

²⁷ This assessment might require adjustment if Ligado proposes a significantly different operational deployment model for its network.

²⁸ The FAA concluded in its 2012 study that the Ligado 1526-1536 MHz downlink signal at 32 dBW exceeded a helicopter GPS receiver's maximum allowed interference power by 24.1 dB for acquisition mode, and by 18.1 dB for tracking mode.

2. Ligado Has Not Demonstrated That the Proposed Operating Conditions Will Protect Non-Certified Receivers Used by the Aviation Industry and Many Others.

The Joint Aviation Parties explained in their comments that the aviation industry relies heavily on non-certified or standard GPS devices in addition to certified receivers.²⁹ To further clarify, these non-certified receivers are used both in ground infrastructure, and also on-board aircraft complementing the functions of the certified aviation receivers.³⁰

Ligado continues to press for the use of an entirely new GPS standard for adjacent band interference protection, proposing to abandon the well-established interference protection criterion of a 1 dB degradation of the GPS C/N₀. The majority of commenters, including leading manufacturers who are the system experts and with whom Ligado reached settlement agreements, raised ongoing concerns regarding unresolved potential interference to standard GPS devices that is yet to be fully resolved and criticized Ligado's insistence on departing from

²⁹ Comments of Joint Aviation Parties at 15.

³⁰ For example, certified aviation GPS receivers provide both location and timing signals to the aircraft databus, which multiple avionics or onboard systems can take an information feed from should they need this data. However, not all avionics systems are capable of receiving this data, or have been designed to source the information directly from the received GPS signal due to different operational requirements or independent safety reasons, hence embedding their own non-certified GPS receiver into their antenna design. Examples of these independent embedded GPS receivers on aircraft systems include SATCOM systems, Enhanced Ground Proximity Warning System ("EGPWS"), Emergency Locator Transmitters ("ELTs"), and Autonomous Distress Tracking ("ADTs") systems. All these systems have the capability to directly receive the GPS signal throughout all stages of flight, and can be found on both fixed wing aircraft, and commercial helicopters. Additionally, all embedded GPS systems are independently designed by the respective manufacturer to operate in the existing GNSS signal environment, including the receiving of other GNSS signals for increased accuracy for some more recent receivers.

the well-established 1 dB metric.³¹ NovAtel, whose comments were endorsed by a number of other commenters,³² raised several methodological flaws in the studies submitted into the record by Ligado performed by Roberson and Associates (“RAA”) based on key performance indicators which merit serious consideration when weighing the value of the RAA results.³³

Leaving aside the procedural concerns of the Commission ignoring the well-established domestic and international standards,³⁴ both Garmin and Trimble unequivocally find Ligado’s proposal “unreliable” and “impractical” as it relies on subjectivity and tries to account for a broad universe of receiver and applications on a case-by-case basis.³⁵ Garmin and Trimble explain that changes in the received C/N₀ metric are the most useful indicators for determining the effect on all four performance attributes required by GPS, namely accuracy, integrity,

³¹ See Comments of Airlines for America at 2; Comments of TopCon at 1-2; Comments of the National Public Safety Telecommunications Council at 5; Comments of Aerospace Industries Association at 2; Comments of RNT Foundation at 3; Comments of NovAtel Inc. at 2-3; Comments of Leica Geosystems at 1-2; Comments of AGCO Corporation at 1; Comments of Phoenix Aerial Systems, Inc. at 1; and Comments of Veripos (US) Inc. at 1.

³² See Comments of NovAtel Inc. at 2-3; Comments of Leica Geosystems at 2; Comments of AGCO Corporation at 1; Comments of Phoenix Aerial Systems, Inc. at 1; and Comments of Veripos (US) Inc. at 1.

³³ See Comments of NovAtel at 2-3.

³⁴ Ligado urges the Commission to change an international standard and approach unilaterally, without suitable coordination or ratification at the international level or with other GNSS systems operating in the same frequency band.

³⁵ Comments of Garmin at 17-18; Comments of Trimble at 12, 16, and 18. Ligado’s claims at p. 13-14 of its Reply that Garmin and Trimble settlements support the Roberson’s testing based on key performance criteria rather than the 1 dB metric is not only inaccurate and misleading, but belied by the comments of both Trimble and Garmin.

continuity, and availability of signals.³⁶ Use of the C/N_0 metric permits both aggregation of interference and the apportionment of interference among multiple sources. Analysis of momentary fluctuations in C/N_0 yield insight into receiver function that otherwise may be masked by averaging. The RAA testing promoted by Ligado only offers a subjective assessment of only one of these key attributes and does not properly account for all attributes of GPS receiver performance. Moreover, the Ligado approach is not coordinated with, or reflective of, other GNSS systems.³⁷

In addition to the significant methodology concerns raised above, the RAA test plan, attached as Appendix A to the Ligado Reply, has flaws in its testing methodology in addition to those identified by NovAtel that would provide inaccurate results or interpretations: As an initial matter, the testing notes that not all existing GPS receivers are compatible with the proposed Ligado emissions. In fact, seven of the 27 devices tested do not fully pass the tests with the existing Ligado emission profile without additional modification, and one device did not provide usable data. Therefore, stating that Ligado's emission are compatible with GPS receivers is, even by Ligado's own proposed metric, not appropriate.

³⁶ See Comments of Garmin at 12-14; Comments of Trimble at 13-14.

³⁷ See Letter of u-blox America, Inc., [full cite] May 20, 2016 (manufacturer of GNSS receivers expressing concerns re inadequacy of Ligado proposed testing methodology to address potential interference to OEM receivers from proposed uplinks in the 1627-1637 MHz and 1646-1656 MHz bands); Letter of u-blox America, Inc. [full cite] June 15, 2016, (same).

In regard to the specifics of the non-certified aviation receiver, the Joint Aviation Reply Commenters view the testing as inadequate in scope. For example, the RAA test plan looks at the Garmin 696 only using static open sky conditions for a 2D position.³⁸ This is not a realistic approach to examine non-certified aviation receivers, as many devices offer altitude data that pilots rely on while in flight. Therefore, realistic testing conditions of non-certified aviation receivers should have included 3D positioning, especially while in motion to replicate real world operations.³⁹ The Joint Aviation Reply Commenters are also investigating other concerns about the testing selection process, and will reply further on the issue as more details emerge.

3. The Ligado Reply Does Not Acknowledge the Concerns Regarding Satellite Communications.

The Joint Aviation Parties and several other commenters, including Iridium, Boeing, and AIA raised concerns regarding interference to SATCOM, specifically the Inmarsat and Iridium systems, on which aviation operations rely heavily both while airborne and on the ground.⁴⁰

³⁸ *Id.* at 328, 259.

³⁹ The Joint Aviation Reply Commenters would note that while the RAA report summarizes that the non-certified aviation receiver was tested in motion, the detailed results later in the report, *i.e.*, Appendix F of the report, shows that it was actually a static test.

⁴⁰ *See* Comments of Joint Aviation Parties at 19-21 For example, aircraft routinely utilize SATCOM on the ground to perform pre-flight checks in order to declare the aircraft ready for service, as the AMS(R)S SATCOM systems such as Inmarsat and Iridium form part of the Minimum Equipment List (“MEL”) for aircraft intended to operate in oceanic or remote areas. Without proper SATCOM connectivity on the ground, an aircraft captain has no way to declare a system operative, and therefore the aircraft would remain grounded until the crew could exercise the equipment. In addition, SATCOM is a backup media to VHF voice communications should there be problems with a VHF radio. If the VHF radio is on maintenance deferral, then an aircraft’s crew utilize SATCOM for all messages

Comments on both the Inmarsat and Iridium systems make clear that the proposed operating conditions are inadequate to confirm the protection of either system at this time. As Iridium noted, without qualification, the proposed operating parameters in the Applications will have a serious interference impact on the Iridium satellite communications.⁴¹ Boeing raised similar concerns with regard to interference to Inmarsat communications, projecting that any solution will likely require retrofitting of existing aircraft at considerable cost.⁴² The airline manufacturer argued that “there will need to be sufficient time to design, test, and certify new transceivers, as well as to deploy them on a rolling basis as individual aircraft become available. The costs to design, manufacture, and install or modify existing transceivers may be substantial, and should not be imposed on incumbent users. The Commission’s grant of Ligado’s modification

between the aircraft and ATC (such as pre departure clearances), along with all airline operational data communications (flight plans, fuel on board, weights, etc.).

⁴¹ See Comments of Iridium at 2; *see also* Comments of Boeing at 2 (discussing the impact on the Inmarsat system).

⁴² Inmarsat itself has also previously highlighted concerns about co-frequency and adjacent band usage of mobile broadband systems in the MSS spectrum with base stations (58 dBm) and handsets (23 dBm) emissions. Noting in a joint submission with Thuraya Telecommunications Company into the ITU-R Joint Task Group 4-5-6-7 (“JTG4567”) that an ongoing ITU-R study’s results “...demonstrate that any MES at least within line-of-sight of an IMT mobile station or base station, and some MESs beyond line-of-sight, could suffer harmful interference.” The conclusion therefore stated that for Mobile Earth Stations (“MES”) “...additional filtering of the MES out-of-band emissions is recommended. The ability to apply improved filtering may require a guardband between the band used for IMT and the band used for MSS. The improved level of filtering and the size of such a guardband would require further study.” ITU-R Contribution, Proposed Revisions to Working Document: Compatibility Studies of the Mobile Service with the Mobile-Satellite Service in the Frequency Bands 1 518-1 559 MHz, 1 626.5-1 660.5 MHz and 1 668-1 675 MHz,” Document ITU-R JTG4567, received July 14, 2014.

application should clearly address these matters, including the appropriate corrective action, the time required for implementation, and the allocation of the cost.”⁴³ The Joint Aviation Reply Commenters concur that any costs imposed on aviation interests in order to permit Ligado to operate its terrestrial system should be identified, quantified and borne by Ligado before the Applications can be granted.⁴⁴

Surprisingly, the Ligado Reply was completely silent as to the progress made to resolve those concerns. Iridium provided more insight, stating that the parties are “in discussion.”⁴⁵ Ligado’s extended discussion and its inclusion of a new study report in its Reply regarding the use of handsets focuses solely on interference “on the right hand side” of the L1 GPS band to GPS systems. Ligado has not provided any results studying the potential for interference to SATCOM from base stations and handsets. The SATCOM interference issue is completely independent of the outcome of the substantial remaining GPS interference issues, and must be fully defined *and* resolved before proceeding further on the Applications.⁴⁶ At this time, it is not possible to conclude this issue on the basis of the current record. The Commission must first understand both the scope of the issue, the costs of transition, and the timing of such transition before considering a grant of the Applications. Ligado should bear the burden, with the

⁴³ Comments of Boeing at 3.

⁴⁴ AIA raised issues similar to those brought forth by Iridium, Boeing, and the Joint Aviation Parties concerning satellite communications. Comments of Aerospace Industries Association at 3.

⁴⁵ Comments of Iridium at 2.

⁴⁶ See Comments of Joint Aviation Parties at 11.

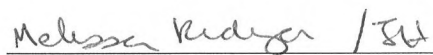
cooperation of the aviation satellite industry, of developing that information and reporting the results back to the Commission and the interested parties.

III. CONCLUSION

As explained in the initial comments of the Joint Aviation Parties and detailed further herein, there are a number of outstanding issues with ensuring adequate protection of aviation safety. Preserving the reliability of aviation operations, which depends not only on certified aviation receivers, but non-certified receivers and SATCOM as well, must be resolved before the Commission can consider the Ligado Applications, whether in their current or modified form. The Joint Aviation Reply Commenters welcome continued engagement with the process to help identify the scope of additional work to be done and the exploration of possible solutions that are operational and economically feasible. However, unless and until those issues are satisfactorily resolved, the Commission should not act to grant the Applications based on good intentions to continue discussing the issues.

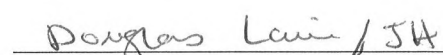
Respectfully submitted,

AIRCRAFT OWNERS AND PILOTS
ASSOCIATION



Melissa K. Rudinger
Vice President Government Affairs
421 Aviation Way
Frederick, Maryland 21701

INTERNATIONAL AIR TRANSPORT
ASSOCIATION



Douglas E. Lavin
Vice President, Member and External
Relations, North America International
1201 F Street NW Suite 650
Washington DC 20004

AIRLINES FOR AMERICA

Captain Billy Nolen /JH
Captain Billy Nolen
Senior Vice President, Safety, Security, and
Operations
1301 Pennsylvania Avenue, NW Suite 1100
Washington DC 20004-1707

NATIONAL AIR TRANSPORTATION
ASSOCIATION

John McGraw /JH
John McGraw
Director, Regulatory Affairs
818 Connecticut Avenue, NW, Suite 900
Washington, D.C. 20006

AVIATION SPECTRUM RESOURCES, INC.

Kris Hutchison /JH
Kris Hutchison
President
180 Admiral Cochrane Drive Suite 300
Annapolis, MD, 21401

NATIONAL BUSINESS AVIATION
ASSOCIATION

Bill Stine /JH
Bill Stine
Technical Advisor
1145 Water Pointe Lane
Reston, Virginia 20194-1035

BRISTOW GROUP, INC.

Robert Phillips /JH
Robert Phillips
VP, Global Business Operations Services
2103 City West Blvd #4
Houston, TX 77042

SOUTHWEST AIRLINES

Neal Young /JH
Neal Young
Manager, Aircraft Communication
2432 Wyman Street
Dallas, TX 75235

HELICOPTER ASSOCIATION
INTERNATIONAL

Matthew Zuccaro /JA.
Matthew S. Zuccaro
President & CEO
1920 Ballenger Avenue
Alexandria, VA 22314-2898

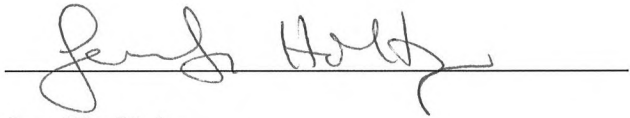
UNITED PARCEL SERVICE

Dontai Smalls /JA.
Dontai Smalls
Vice President, Public Affairs
316 Pennsylvania Ave. SE
Suite 300
Washington, DC 20003-1173

June 21, 2016

Certificate of Service

I hereby certify that a true and correct copy of these comments of the Joint Aviation Parties was served upon the parties listed below on this 21st day of June 2016 by hand delivery.

A handwritten signature in cursive script, appearing to read "Jennifer Holtz", is written over a horizontal line.

Jennifer Holtz
Kelley Drye & Warren
3050 K Street NW
Suite 400
Washington, D.C. 20007

Jeffrey Carlisle
LIGHTSQUARED SUBSIDIARY LLC
10801 Parkridge Boulevard
Reston, VA 20191

Gerald Waldron
COVINGTON & BURLING LLP
One CityCenter
850 Tenth Street, NW
Washington, DC 20001